Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

In the Matter of	)	
	)	
Mitigation of Orbital Debris in the New Space Age	)	IB Docket No. 18-313
	)	

REPLY COMMENTS OF THE BOEING COMPANY

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SUMMARY

The commercial satellite industry is entering an extended period of substantial growth and development, which could rapidly become a major driver of international commerce. U.S. based companies are positioned to fulfill a leading role in this economic growth. The Federal Communications Commission should therefore refrain from adopting any new regulations and information disclosure requirements addressing the mitigation of orbital debris without first coordinating its proposals closely with other U.S. and international entities that have significant expertise and, in some cases, an executive mandate to take the lead in this area.

The vast majority of commenters—some of them U.S. federal agencies—urged the Commission to employ a multistep approach, first by participating in federal activities that are focused on this area, such as the National Space Council's Interagency Working Group on Commercial Orbital Debris Requirements. Employing the outputs from these deliberations, the Commission could then develop rules that reflect the significant expertise of other federal agencies, while appropriately balancing the goals of ensuring U.S. leadership in the commercial space industry.

The mitigation of orbital debris is an important undertaking, but it is also inherently global in scope. Therefore, the Commission must also work closely with international organizations to develop standards and requirements that are supported by regulators in each of the major space faring nations. Absent such consensus, any rules adopted by the Commission will become obstacles to U.S. industry and further encourage space entrepreneurs to base their operators and licensing efforts overseas. Such an outcome would benefit neither the important goals of orbital debris mitigation nor the economic leadership of U.S. industry.

In assessing the comments and recommendations of various commercial entities, the Commission must also ensure that advocates for much more stringent requirements—particularly those that have already launched their satellites or have secured their licenses overseas—do not result in the creation of substantial new barriers for new entrants in the commercial space industry, or impose a competitive disadvantage for U.S. licensees. Some of the debris mitigation rules supported by certain parties would impose tremendous costs on new entrants, often without a demonstration of their efficacy. Other proposed rules, such as mandatory spacing between non-geostationary satellite orbit systems, could increase the scarcity of space for new constellations particularly in low earth orbit.

Finally, the Commission must ensure that its rules and information disclosure requirements are transparent and objective. A number of parties counseled the Commission to refrain from adopting any new information disclosure requirements unless those rules are coupled with clear metrics and criteria regarding the levels of performance that will be presumptively acceptable by the Commission in order to justify the grant of a space station license. Absent such clear mandates, the Commission's regulations could be viewed as arbitrary or subjective, further discouraging new entrants from employing the U.S. satellite licensing process.

With these major principles as background, and following careful consideration of the comments of others in this proceeding, Boeing provides in these reply comments its updated views and recommendations on each of the proposals identified in the Commission's Notice of Proposed Rulemaking.

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The Boeing Company ("Boeing") herein replies to the comments that were filed in response to the Commission's Notice of Proposed Rulemaking ("*NPRM*") addressing the mitigation of orbital debris.[1] In this response, Boeing addresses each of the substantive regulatory proposals raised in the *NPRM* and the comments that were filed addressing these issues. As a preliminary matter, however, Boeing emphasizes two critical issues that are paramount for the Commission in identifying its next steps in this proceeding.

First, nearly all parties agree that the Commission should carefully coordinate its regulatory efforts on orbital debris with other federal agencies that have substantial expertise and an executive mandate to formulate U.S. policy in this area. Second, the Commission must ensure that any new regulation of orbital debris is not misused as a potential barrier to impede new entrants in the commercial space industry, or to provide non-U.S. satellite operators with a competitive advantage over U.S. licensees. Each of these issues is critically important to ensure that the United States maintains its global leadership in commercial space exploration and development, an industry that

[1] *See* Mitigation of Orbital Debris in the New Space Age, *Notice of Proposed Rulemaking*, FCC 18-159 (Nov. 19, 2018) ("*NPRM*").

will inevitably become one of the single most important drivers of international commerce and an important contributor to our national security.[2]

I. THE COMMISSION MUST CAREFULLY COORDINATE ITS RULEMAKING EFFORTS WITH OTHER FEDERAL AGENCIES THAT HAVE SUBSTANTIAL EXPERTISE AND AN EXECUTIVE MANDATE IN THIS FIELD

The vast majority of parties that filed comments in this proceeding strongly urged the Commission to refrain from taking any action without first closely coordinating its action with other U.S. federal agencies and international organizations with specific expertise in the field of orbital debris.[3] The U.S. Department of Commerce took the lead in expressing this caution,

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[2] *Driving Space Commerce Through Effective Spectrum Policy*, U.S. Dept. of Commerce, Office of Science and Technology Policy, The White House, at 3 (March 26, 2019), *available at https://www.commerce.gov/sites/default/files/2019-03/DrivingSpaceCommerce.pdf* (last visited May 6, 2019) (explaining that "no country in the world is more reliant on space for its security, economy, and international status").

[3] Comments of The Aerospace Corporation, IB Docket No. 18-313, at 6 (Dec. 9, 2018) ("Aerospace Comments") (noting the risks involved in "creating different sets of rules, if not sufficiently coordinated," with other regulatory bodies"); Comments of The Boeing Company, IB Docket No. 18-313, at 4 (Apr. 5, 2019) ("*Boeing Comments*") (urging the FCC to "exercise caution in ensuring that any additional rules addressing orbital debris that are adopted in this proceeding are closely coordinated with the initiatives of other federal agencies and do not diverge appreciably from the orbital debris standards and recommendations being adopted by the international community); Comments of The Commercial Smallsat Spectrum Management Association, IB Docket No. 18-313, at 2-4 (Apr. 5, 2019) ("*CSSMA Comments*") (urging the FCC to "integrate relevant technical expertise of other U.S. Federal agencies or government bodies and avoid creating piecemeal and potentially duplicative regulation"); Comments of the Consortium for the Execution of Rendezvous and Servicing Operations, IB Docket No. 18-313, at 3 (Apr. 4, 2019) (urging "the U.S. government to consider consolidating the orbital debris mitigation guidelines into a single framework under a single agency"); Comments of EchoStar Satellite Operating Corporation and Hughes Network Systems, LLC, IB Docket No. 18-313, at 4 (Apr. 5, 2019) ("*Echostar Comments*") (recommending that the FCC "should narrowly construe its jurisdiction to reflect its core competencies with respect to orbital debris" and should "defer to the authority and expertise of other U.S. or international agencies tasked with developing specific technical criteria for mitigating orbital debris"); Comments of the European External Action Service, Space Task Force, IB Docket No. 18-313, at 1 (Apr. 3, 2019) ("*EEAS Comments*") (noting the importance of addressing these issues at an "international level" and urging the FCC "to ensure that the new rules proposed by the FCC are consistent with applicable international rules, including those on the trade of goods and services"); Comments of Eutelsat S.A., IB Docket No. 18-313, at 13 (Apr.

5, 2019) ("*Eutelsat Comments*") (encouraging "continued international cooperation to preserve a common framework of regulation for orbital debris prevention and management, such as that promulgated by the Inter-Agency Space Debris Coordination Committee"); Comments of Intelsat License LLC, IB Docket No. 18-313, at 1 (Apr. 5, 2019) ("*Intelsat Comments*") (urging the FCC "to carefully consider the work of these other agencies and organizations in the interest of avoiding duplicative requirements and inconsistent standards"); Comments of Lockheed Martin Corporation, IB Docket No. 18-313, at 3 (Apr. 5, 2019) ("*Lockheed Comments*") (cautioning that "only with a concerted effort – with the United States Government as a unified whole taking the lead in relevant fora such as the Inter-Agency Space Debris Coordination Committee ("IADC") and the Scientific and Technical Subcommittee of the United Nations Committee on the Peaceful Use of Outer Space ("UN COPUOS") – that the long-term sustainability of the globally-shared space domain for U.S. space system operators and all others will be ensured"); Comments of Maxar Technologies Inc., IB Docket No. 18-313, at 3 (Apr. 5, 2019) ("*Maxar Comments*") (explaining that the FCC "must undertake a holistic review of orbital debris policies across all federal agencies with responsibilities for authorizing and licensing commercial space activities"); Letter from Anne E. Sweet, NASA Representative to the Commercial Space Transportation Interagency Group Human Exploration and Operations Mission Directorate, Launch Services Office, to Marlene Dortch, Secretary, Federal Communications Commission, IB Docket No. 18-313, at 8 (Apr. 4, 2019) ("*NASA Comments*") (recommending "consultation between the respective Federal entities in these instances to eliminate any ambiguity and potential duplication"); Comments of Orbcomm Inc., IB Docket No. 18-313, at 5-6 (Apr. 5, 2019) ("*Orbcomm Comments*") (urging the FCC to let other expert agencies "take the lead, with the Commission assuming a complementary role"); Comments of the Satellite Industry Association, IB Docket No. 18-313, at 3 (Apr. 5, 2019) ("*SIA Comments*") (observing that "several other federal agencies possess technical expertise and resources that may be pertinent to the development of principles and guidelines of aerospace operations and maneuvers"); Comments of Space Exploration Technologies Corp., IB Docket No. 18-313, at 4 (Apr. 5, 2019) ("*SpaceX Comments"*) (explaining that coordination with other federal agencies, including establishing which Federal agency has the appropriate lead for a given activity, "will help avoid confusion, eliminate regulatory duplication, streamline processing, and avert conflicts in requirements across agencies"); Comments of Space Logistics LLC, IB Docket No. 18-313, at 1 (Apr. 5, 2019) ("*Space Logistics Comments*") (explaining that the FCC should be mindful that "other stakeholders, including other government agencies and commercial enterprises, may have considerably more operational and technical expertise, and accordingly, deferring to best practices and standards established by those entities may be in the public interest"); Comments of Spaceflight, Inc., IB Docket No. 18-313, at 7 (Apr. 5, 2019) ("*Spaceflight Comments*") (encouraging the FCC to work with NASA, other federal agencies and international organizations to agree on "a single set of standards for the mitigation of orbital debris that will apply regardless of which state's licensing administration will govern"); Comments of Telesat Canada, IB Docket No. 18-313, at 1 (Apr. 5, 2019) ("*Telesat Comments*") (recommending the adoption of rules that draw "on existing and developing agency and industry expertise and the evolving domestic and international landscape of stakeholder agencies and groups"); Comments of WorldVu Satellites Limited, IB Docket No. 18-313, at 2 (Apr. 5, 2019 ("*OneWeb Comments*") (encouraging the FCC "to ensure this proceeding contributes to a regulatory framework that gives due consideration to the subject matter expertise and resources possessed by other federal agencies and expert regulatory bodies").

respectfully requesting that the Commission "defer action in this proceeding until completion of the agency actions mandated by the President's Space Policy Directives."[4] The Department of Commerce observed that the Commission has a statutory directive to adopt rules that serve the public interest and the fulfillment of this mandate would be incomplete absent "the fulsome incorporation of the President's policies on space commerce and the corresponding expertise, initiatives, and rulemakings of the federal agencies tasked by the President in the Space Policy Directives with carrying out those policies."[5]

In urging the Commission to coordinate is regulatory efforts closely with other federal agencies, the Commission is not being asked to "stand still"[6] and would not be "ceding its authority" or letting others "take the lead."[7] The Department of Commerce expressly invited "the Commission's participation in an Interagency Working Group on Commercial Orbital Debris Requirements."[8] Further, each of the Administration's recent Space Policy Directives require "consultation" and "coordination" with the Commission on the development of orbital management issues.[9] Thus, although Boeing acknowledges the Commission's frustration in its

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[4] Comments of the United States Department of Commerce, IB Docket No. 18-313, at 3 (Apr. 5, 2019) ("*Department of Commerce Comments*").

[5] *Id.*

[6] Comments of Commissioner O'Rielly, FCC Open Agenda Press Conference, April 12, 2019, *available at: https://www.fcc.gov/news-events/events/2019/04/april-2019-open-commission-meeting* (*statement at* 2:04:33).

[7] Comments of Commissioner Rosenworcel, FCC Open Agenda Press Conference, April 12, 2019, *available at: https://www.fcc.gov/news-events/events/2019/04/april-2019-open-commission-meeting* (*statement at* 2:18:53).

[8] *Department of Commerce Comments* at 3.

[9] Space Policy Directive-3, National Space Traffic Management Policy, Presidential Memorandum, at Sec. 6 (June 18, 2018), *available at:* https://www.federalregister.gov/documents/2018/06/21/2018-13521/national-space-traffic-

exclusion from the National Space Council,[10] the fact remains that the Commission will have an active and important role to play in the joint development of U.S. policy in this area in consultation with other federal agencies.

Proceeding in a closely coordinated manner is also consistent with the previous statements of the Commissioners. As Commissioner O'Rielly acknowledged, "the Commission is not the lead governmental agency dealing with this issue, with both domestic and international entities containing far greater expertise and authority."[11] Instead, as Commissioner Carr highlighted, "a number of our sister agencies . . . have expertise and jurisdiction over the launch and tracking of satellites, including NASA, DOD, the FAA, the State Department, and the new Office of Space Commerce." Commissioner Rosenworcel has also repeatedly argued that "the FCC needs to coordinate more closely with other federal authorities to figure out just what our national policies are for this jumble of new space activity."[12] Further, Commissioner Carr requested the addition of questions in the *NPRM* addressing "What are the right agencies and experts to answers these questions? Should the FCC be one of the lead agencies? Should we play a supporting and coordinating role instead?"

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management-policy (*last visited* April 24, 2019); Space Policy Directive-2, Streamlining Regulations on Commercial Use of Space, Presidential Memorandum, at Secs. 3 and 5 (May 24, 2018), *available at:* https://www.federalregister.gov/documents/2018/05/30/2018-11769/streamlining-regulations-on-commercial-use-of-space (*last visited* April 24, 2019).

[10] Streamlining Licensing Procedures for Small Satellites, *Notice of Proposed Rulemaking*, FCC 18-44 (Apr. 17, 2018), Statement of Commissioner Jessica Rosenworcel.

[11] *NPRM*, Statement of Commissioner Michael O'Rielly.

[12] Streaming Licensing Procedures for Small Satellites, *Notice of Proposed Rulemaking*, FCC 18-44 (Apr. 17, 2018), Statement of Commissioner Jessica Rosenworcel; *see also NPRM,* Statement of Commissioner Jessica Rosenworcel, Concurring (repeating this same statement).

Given this thorough acknowledgement within the Commission of the complexity and importance of the interrelationships within the U.S. federal government that are highly relevant to these issues, it should be beyond question that the adoption of new orbital debris rules be deferred until the completion of a comprehensive examination by the U.S. federal government of the regulatory environment for commercial space and the measures that should be taken to address orbital debris while preserving and promoting the U.S. commercial space industry. The Commission should therefore align its regulatory efforts with this comprehensive process.

II. THE COMMISSION MUST ENSURE THAT ITS ORBITAL DEBRIS RULES ARE NOT MISUSED AS A BARRIER TO MARKET ENTRY IN THE COMMERCIAL SPACE INDUSTRY

In reviewing the comments that were filed by other parties in this proceeding, Boeing is pleased to observe that its recommendations to the Commission often aligned closely with those of NASA. Boeing has tremendous respect for NASA's expertise in orbital debris mitigation and collision avoidance strategy. As NASA modestly explained, its significant expertise in these areas is derived in part from of its "considerable assets in low-Earth orbit (LEO) including astronauts living and working on orbit, the International Space Station (ISS), and more than twenty high-value scientific spacecraft."[13]

NASA's recommendations to the Commission can be generally characterized as providing a reasonable balance between the important need for orbital debris mitigation and the significant costs and burdens that would result from the imposition of substantially more aggressive mitigation requirements. In contrast, a few parties supported the adoption and enforcement of new rules

[13] *NASA Comments* at 1.

that would be exceedingly burdensome to U.S. satellite operators, often without any demonstration of their efficacy.

Those parties supporting more aggressive positions can largely be grouped into two categories. One group includes start up enterprises and consultants that likely envision new business opportunities in orbital management and debris mitigation, including the direct retrieval of retired spacecraft. Boeing strongly supports the development of new technologies and capabilities to support debris mitigation. Boeing also concurs with those parties that urge the U.S. government to directly support such efforts, including through NASA grants and DARPA development programs.[14] The Commission, however, must refrain from adopting any rules that require the use of orbital management or debris mitigation capabilities that are not yet sufficiently mature to be used in a safe and cost effective manner.

A second group of parties seeking the adoption of relatively aggressive regulatory requirements includes several incumbent operators and authorization holders of non-geostationary satellite orbit ("NGSO") systems. Two such parties, Iridium and Orbcomm, recently launched second generation satellite constellations and may not become subject to many of the Commission's revised orbital debris rules until they seek authority for a third generation of satellites in the future. Another authorization holder, OneWeb, secured its NGSO system license

[14] *See, e.g.,* Comments of Global NewSpace Operators, IB Docket No. 18-313, at 15 (Apr. 5, 2019) ("*GNO Comments*") (explaining that DARPA is funding the development of low cost transponder devices, including some that are RFID based and do not require a power source); *GNO Comments* at 21 (arguing that the U.S. government should adopt policies that support research and development of commercial systems that mitigate and remediate orbital debris, including U.S. government debris); Comments of the Secure World Foundation, IB Docket No. 18-313, at 5 (Apr. 4, 2019) ("*SWF Comments*") (arguing that the satellite industry needs more incentive to development advancements in the direct retrieval of orbital debris, such as government grants).

from another country and has made no offer to submit to the jurisdiction of the Commission's orbital debris requirements.[15]

Although existing operators have a legitimate interest in protecting their satellite assets in space, the Commission should exercise caution in ensuring that their push for relatively aggressive orbital debris rules does not increase excessively the substantial investment and orbital access barriers that exist for new entrants. Intrusive debris mitigation requirements can substantially increase the costs of new satellite systems. Further, overly protective proposals, such as a requirement to maintain dead zones in space as large buffers between NGSO satellite systems, exacerbates the scarcity of desirable orbital altitudes, particularly for LEO satellite systems.

Fortunately, the Commission has substantial expertise in the context of radio spectrum management in balancing the competing needs of incumbents with those of new entrants and evolving technologies. Since its inception, the Commission has routinely confronted "conflict[s] between legacy stakeholders and new entrants where deployment of new technologies and services threatens to adversely impact an incumbent or place restrictions on the new entrant."[16] Examples include navigating spectrum interference issues between new cellular radio systems and public

[15] *See OneWeb Comments at 1* (indicating that, as a U.K.-based satellite operator, OneWeb "is subject to the regulation and oversight of the United Kingdom Space Agency").

[16] Public Notice, *Office of Engineering and Technology, Wireless Telecommunications Bureau, and Office of Strategic Planning Announce Workshop on "Spectrum Efficiency and Receiver Performance*, DA 12-280 (Feb. 24, 2012).

safety radio systems,[17] satellite digital radio systems and proposed terrestrial data services,[18] unlicensed WiFi systems and FAA weather radar systems,[19] and ancillary terrestrial service on mobile satellite spectrum and GPS.[20] Throughout these proceedings, the Commission's balancing efforts have been guided in part by Section 7 of the Communications Act, which instructs that it is "the policy of the United States to encourage the provision of new technologies and services to the public."[21]

Consistent with this statutory mandate, the Commission must carefully balance its consideration of new orbital debris rules to ensure that any additional mitigation and orbital management requirements do not impede excessively the development and launch of new satellite systems by U.S. operators seeking to provide new services to end users. Instead, the Commission should adhere closely to the recommendations of expert agencies, such as NASA, and the policy guidance of executive agencies, such as the Department of Commerce. The Commission should also consider the detailed input of the U.S. space industry, but with an overt balancing of interests

[17] *See* Improving Public Safety Communications in the 800 MHz Band, WT Docket 02-55, *Report and Order, Fifth Report and Order, Fourth Memorandum Opinion and Order, and Order*, 19 FCC Rcd 14969 (2004).

[18] *See* Establishment of Rules and Policies for the Digital Audio Radio Satellite Service in the 2310-2360 MHz Frequency Band, WT Docket No. 07-293, *Report and Order, Second Report and Order* (May 20, 2010).

[19] *See FCC Memorandum*, Elimination of interference to Terminal Doppler Weather Radar (TDWR), from Julius Knapp, Chief, FCC Office of Engineering and Technology, P. Michele Ellison, Chief, FCC Enforcement Bureau, (July 27, 2010).

[20] *See FCC Public Notice*, International Bureau Invites Comment On NTIA Letter Regarding Lightsquared Conditional Waiver, DA 12-214, IB Docket No. 11-109 (Feb. 15, 2012).

[21] 47 U.S.C. § 157 (Communications Act § 7).

between incumbent operators and authorization holders and those companies still seeking authority to introduce new satellite services to end users.

III. THE COMMISSION SHOULD ADOPT ONLY THOSE PROPOSALS THAT ARE SUFFICIENTLY MATURE TO BE EXPRESSED USING TRANSPARENT AND OBJECTIVE METRICS AND REQUIREMENTS

To facilitate the continued growth and development of the U.S. space industry, the Commission must refrain from adopting any additional orbital debris rules or information disclosure requirements unless those rules include specific metrics and criteria that can be used by license applicants and the FCC staff to determine what is presumptively sufficient and acceptable to warrant the grant of a space station authorization. Boeing is not alone in arguing for this regulatory transparency.

The Satellite Industry Association, for example, asserted that "any new or amended rules adopted in this proceeding should be guided by principles of regulatory certainty, transparency, and comprehensiveness."[22] Lockheed Martin further explained that the Commission "cannot, and should not, leave applicants and/or licensees in a position of providing information without understanding at the outset how that information is to be used to assess their orbital debris mitigation plans" and that "unfulfilled disclosure obligation creates regulatory uncertainty in terms of space system design and promotes the development of an experiential body of rulings/precedents on an *ad hoc* basis that may be detrimental to U.S. industry."[23] OneWeb also encouraged this approach, noting that "adopting easily discernible rules, providing continued transparency to industry, consistently and even-handedly enforcing applicable standards, and

[22] *SIA Comments* at 3.

[23] *Lockheed Comments* at 6.

carefully observing clear jurisdictional and statutory limits remain the essential qualities of effective agency regulation."[24] In addition, the joint comments of university researchers observed that excessive information disclosure requirements such as those proposed in the *NPRM* will impede universities from conducting important scientific missions on a timely basis.[25]

Given the need for transparency and objectivity in the Commission's rules, the concern about open ended information disclosure requirements was highlighted repeatedly in Boeing's comments and are again highlighted in its reply comments below with respect to many of the regulatory proposals identified in the *NPRM* for consideration by the Commission.

A. The Commission Should Not Adopt Information Disclosure Requirements for Uncoupled Deployment Mechanisms Absent a Clear Statement Articulating When Their Use Should be Permitted

Boeing continues to oppose the adoption of an information disclosure requirement regarding the use of uncoupled deployment mechanisms unless the Commission concurrently provides clear and objective criteria articulating when the use of such devices is permissible.[26] As a number of parties explained in their comments, uncoupled deployment mechanisms can be extremely useful in ensuring adequate spacing between satellites, to avoid collisions between

[24] *OneWeb Comments* at 2.

[25] Comments of University Small-Satellite Researchers, IB Docket No. 18-313, at 17 (Apr. 5, 2019) ("*USSR Comments*").

[26] *See also GNO Comments* at 6 (arguing the Commission should identify when the use of such mechanisms are appropriate and will be permitted). In maintaining this position, Boeing acknowledges that NASA indicated that satellite license applications should be required to disclose the release of any object that does not itself require an FCC license. *See NASA Comments* at 2.

adjacent spacecraft,[27] and to reduce the number of launches required to complete a constellation.[28] Therefore, the Commission should clearly indicate that the use of such devices continues to be permitted.

An information disclosure requirement for uncoupled deployment devices would also be extremely burdensome to satellite license applicants because they often will not know when they prepare their applications whether any uncoupled deployment devices will be used by the launch provider or the characteristics of any such devices that are used.[29] Therefore, the Commission should refrain from adopting an information disclosure requirement for uncoupled deployment mechanisms. The Commission should also refrain from adopting other burdensome proposals identified by some parties, such as requiring launch licenses or the inclusion of RF beacons on uncoupled deployment mechanisms,[30] the consideration of which arguably exceeds the Commission's jurisdictional authority.

B. The Commission Should Not Adopt Information Disclosure Requirements Regarding the Potential Release of Liquids

No party expressed support for the adoption of an information disclosure requirement addressing the use of propellant or coolant liquids that, if released into space, could remain in droplet form. Those parties that did address the issue expressed concern regarding the manner in

[27] *See Boeing Comments at 8; CSSMA Comments* at 4; Comments of D-Orbit, IB Docket No. 18-313, at 2 (Dec. 1, 2018) ("*D-Orbit Comments*"); *Spaceflight Comments* at 1-3.

[28] *See Spaceflight Comments* at 5-6.

[29] *See Eutelsat Comments* at 3; Comments of Tyvak, Inc., IB Docket No. 18-313, at 1 (Apr. 5, 2019) ("*Tyvak Comments*").

[30] Comments of Satellite Design for Recovery, IB Docket No. 18-313, at 4 (Feb. 20, 2019) ("*Satdfr.org Comments*").

which such a disclosure requirement might be interpreted and the restrictions that might be imposed. For example, some parties argued that it is premature to develop regulations governing this area, particularly absent further evidence that such liquids, if released, will persist in droplet form.[31] Other parties sought clarification from the Commission that any restriction adopted on the release of liquids will permit the venting of volatile liquids and pressurants that could pose future fragmentation risks but will not form hazardous droplets.[32]

In addition, Boeing continues to be concerned about the need for confidential treatment of such information. The development and use of new spacecraft propellants is a highly competitive field. Boeing treats its propellants as highly proprietary and would not permit its customers to make public disclosures regarding their characteristics. Therefore, given the limited record on this issue and the absence of any persuasive support, the Commission should refrain from adopting information disclosure requirements regarding the potential release of liquids.

C. The Commission Should Adopt a Presumption That Each Satellite Should be Designed Such that the Probable Risk of a Collision With a Large Object is No More Than 0.001

Boeing concurs with those parties that support the Commission's proposal to adopt the NASA standard that each satellite should be designed in a manner that the probable risk of a collision with a large object not exceed 0.001.[33] Boeing further agrees that satellite applicants should be permitted to use the NASA DAS software to demonstrate compliance.[34] In supporting

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[31] *CSSMA Comments* at 5-6; *Tyvak Comments* at 1.

[32] *Aerospace Comments* at 7.

[33] *OneWeb Comments* at 16; *Orbcomm Comments* at 7-8.

[34] *USSR Comments* at 13-14.

this proposal, Boeing acknowledges that the DAS software is susceptible to variation based on the input parameters employed by satellite operators.[35] Therefore, the 0.001 metric should be employed as a rebuttal presumption rather than an absolute ceiling.

The Commission, however, should adhere to NASA guidelines and its specific recommendations in this proceeding by applying its collision avoidance lifetime requirement of 0.001 on a per-satellite basis and not aggregated to an entire constellation.[36] The arbitrary application of the NASA metric on a per-system basis would inappropriately impose vastly different requirements on different operators based solely on the size of their proposed constellation.[37] Those parties that support the application of the NASA metric to satellite constellations on an aggregate, system-wide basis provided no technical basis to justify this radical change and appear intent on erecting a barrier to entry for new satellite systems,[38] or they have not fully considered the burdensome impact that would result on large satellite systems.[39]

The Commission should also reject proposals to define large objects based on factors that may be subject to change, such as whether the object is trackable by an entity such as the U.S. Strategic Command ("JSpOC").[40] Instead, in order to facilitate the objective application of the

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[35] *SpaceX Comments* at 11-12; *Intelsat Comments* at 8; Comments of Integrity Applications, IB Docket No. 18-313, at 3 (Dec. 18, 2018) ("*Integrity Applications Comments*").

[36] *NASA Comments at 3*; Comments of LeoSat MA, Inc., IB Docket No. 18-313, at 3 (Apr. 5, 2019) ("*LeoSat Comments*").

[37] *SpaceX Comments* at 15-16; Comments of Association of Space Explorers, IB Docket No. 18-313, at 8 (March 18, 2019) ("*ASE Comments*").

[38] *OneWeb Comments* at 16; *Orbcomm Comments* at 7-8;

[39] *GNO Comments* at 6; *CSSMA Comments* at 7.

[40] *SpaceX Comments* at 6; *GNO Comments* at 6.

0.001 metric, the Commission should follow the proposal of NASA and others in continuing to conclude that the definition of large objects should be 10 cm or more.[41]

Finally, at least for the present, the Commission should continue to adhere to the NASA practice of treating any spacecraft that is maneuverable as posing zero or near zero risk of a collision with large objects. This is the recommendation that was provided to the Commission by NASA and others.[42] NASA acknowledged that this issue is the subject of studies to determine if a more accurate conclusion can be reached.[43] Pending the completion of such studies, the Commission should defer consideration of proposals by several parties to treat maneuverable satellites as entailing a quantifiable risk of collision with large objects,[44] in part because any risk that may exist currently cannot be quantified, at least without additional information.[45]

D. The Commission Should Not Impose Minimum Spacing Requirements Between NGSO Satellite Systems

Some existing operators filed comments urging the adoption of minimum spacing requirements between NGSO satellite systems and prohibiting the operation of NGSO systems

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[41] *NASA Comments* at 3; *Aerospace Comments* at 8 and 13 (arguing that the use of any other definition will make regulatory compliance unachievable).

[42] *NASA Comments* at 2-3; Comments of SES Americom, Inc. and O3b Limited, IB Docket No. 18-313, at 2 (Apr. 5, 2019) ("*SES/O3b Comments*").

[43] *NASA Comments* at 2-3.

[44] *OneWeb Comments* at 16; Comments of Iridium Communications Inc., IB Docket No. 18-313, at 3 (Apr. 5, 2019) ("*Iridium Comments*"); *Aerospace Comments* at 8; *CSSMA Comments* at 8-9; *Tyvak Comments* at 1.

[45] If the Commission concludes that the immediate adoption of a metric applicable to satellites with propulsion, then Boeing would not object to the proposal of The Aerospace Corporation that the metric be set at $1x10^{-6}$, which is the collision risk limit identified in Air Force Instruction ("AFI") 91-217 applicable to reusable launch vehicles. *See Aerospace Comments* at 8.

with overlapping orbital altitudes.[46] As a preliminary point, this is a proposal that was not identified for comment in the *NPRM* and is therefore beyond the scope of the current rulemaking proceeding.

Even were the topic within the purview of this proceeding, Boeing would recommend against its implementation because it could result in scarce orbital resources being left fallow. Satellite system operators and their notifying administrations, in this case, the Commission, have an obligation to ensure that scarce orbital resources are used in an efficient manner. The Communications Act recognizes the importance of ensuring the "efficient use" of orbital resources.[47] In addition, Article 44 of the ITU Constitution directs Member States that orbits are "limited natural resources and that they must be used rationally, efficiently and economically."[48]

This said, Boeing could support the proposal of the Aerospace Corporation that a minimum altitude spacing of 20 kilometers be maintained between the outermost satellites of large NGSO constellations employing circular orbits.[49] In contrast, when this issue was raised previously with the Commission, the proponent of mandatory spacing sought a "Safety Buffer Zone" of 125 kilometers.[50] OneWeb later clarified that it meant a separation distance of 125 kilometers

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[46] *OneWeb Comments* at 2-6; *Iridium Comments* at 4.

[47] *See* 47 USC § 753(a)(3).

[48] Constitution of the International Telecommunication Union, Article 44 (2015).

[49] *See Aerospace Comments* at 11 (explaining that, "[u]sing the current public covariance information, it is necessary to keep a 10 km separation from another object to have a collision probability on the order of 1x10-6" and, coupled with natural orbit variations, this suggests that a separate distance of 20 kilometers would be appropriate).

[50] *See, e.g.,* Comments of Worldvu Satellites Limited, IBFS File No. SAT-LOA-20161115-00118, at 11-12 (June 26, 2017) (calling for a 125 km buffer zone between NGSO constellations).

between the centers of two constellations rather than their outermost satellites.[51] Of course, this still would have resulted in an unnecessarily large separation distance between NGSO constellations that space their satellites and orbital planes in an efficient manner.

In any event, when this issue was addressed previously, the Commission appropriately concluded that OneWeb had failed to provide legal or technical justification for its proposal.[52] The Commission further concluded that such issues are most appropriately addressed "through inter-operator coordination."[53] Boeing concurs with these findings and urges the Commission to refrain from adopting any rules that would arbitrarily impose a minimum spacing requirement between the altitudes of NGSO satellite systems.

E. The Commission Should Adopt a Presumption That Each Satellite Should be Designed Such that the Probable Risk of it Becoming a Source of Orbital Debris as a Result of a Collision With Small Objects is No More Than 0.01

Boeing continues to support the *NPRM* proposal to adopt a presumption that each satellite be designed in a manner that the probable risk of it becoming a source of orbital debris as a result of a collision with small objects not exceed 0.01. NASA recommended the adoption of this metric, explaining that it should be applied on a per-satellite basis rather than arbitrarily applied on a per-system basis.[54] NASA further explained that damage from collisions with small objects

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[51] *See* WorldVu Satellites Limited, Consolidated Opposition and Reply Comments on OneWeb, IBFS File No. SAT-MOD-20180319-00022, at 21 (Aug. 27, 2018) ("*OneWeb Opposition*").

[52] *See* Space Exploration Holdings, LLC, Application For Approval for Orbital Deployment and Operating Authority for the SpaceX NGSO Satellite System, *Memorandum Opinion, Order and Authorization*, FCC 18-38, ¶ 11 (Mar. 29, 2018).

[53] *Id.*

[54] *NASA Comments* at 3; *see also SpaceX Comments* at iii; *ASE Comments* at 9.

can be avoided through the use of shielding, redundant systems, or other cost-effective design or operational options,[55] which Boeing routinely employs.

Boeing acknowledges the difficulties that exist in modelling the collision risks with small objects,[56] particularly given the fact that prior studies on the orbital density of small objects have focused only on altitudes below 600 kilometers. Nevertheless, conducting the analysis and mandating compliance with the 0.01 metric, at least on a presumptive basis, remains valuable.

F. The Commission Should Update its Disclosure Requirements for NGSO System Applicants With Respect to Their Coordination With Other Potentially Affected NGSO Systems

Boeing continues to support the Commission's proposed changes to its orbital debris rules with respect to the information disclosure requirements of NGSO satellite system applicants seeking to operate in an orbit that is similar in altitude or other relevant characteristic of existing or planned NGSO satellite systems.[57] Boeing disagrees, however, with those parties that argue that coordination between NGSO system operators can be achieved effectively only using a central controlling authority.[58] The operation and management of a large NGSO satellite system is an extremely complex undertaking which can be accomplished successfully only by a very sophisticated and well-equipped satellite operator. These sophisticated operators are fully capable of working with the operators of other NGSO systems to arrange efficient information sharing and coordination procedures to the extent they are needed between two systems. In

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[55] *NASA Comments* at 3.

[56] *SpaceX Comments* at 11-12; *GNO Comments* at 6-7

[57] *See NPRM*, ¶ 28.

[58] *Aerospace Comments* at 9; *ASE Comments* at 9.

contrast, the appointment of a single authority to manage the information sharing and coordination of every NGSO system would likely result in an unwieldy bureaucratic structure that would lack the flexibility and responsiveness that is necessary to successfully carry out such a task. By updating its disclosure requirements for NGSO system applicants, the Commission will enable coordination with other potentially affected NGSO systems to be performed in an effective and efficient manner.

G. The Commission Should Limit Any New Information Disclosure Requirements Regarding Satellites Transiting the Altitude of the International Space Station

Boeing continues to believe that the Commission should adopt an information disclosure requirement for NGSO systems regarding any operational constraints that may be caused to the ISS or other manned spacecraft only if the Commission concurrently adopts objective criteria regarding the avoidance measures that would be presumptively sufficient to warrant Commission approval. To this end, NASA has explained that the risks to the ISS posed by spacecraft in circular orbits above the ISS, and decaying passively through the ISS altitude range, pose a small likelihood of requiring an avoidance maneuver for the ISS.[59] Based on this guidance, the Commission should conclude that an operator's planned avoidance measures are presumptively sufficient if they are likely avoid any impact to the ISS or other manned spacecraft absent an anomaly.

[59] *NASA Comments* at 3-4. NASA notes, however, that satellites in elliptical orbits, although helpful to accelerate the post-mission disposal process, can significantly extend the timeframe that the object is crossing the ISS altitude and could impose a significant disruption to ISS operations. *See id.*

H. The Commission Should Not Attempt to Regulate the Highly Sensitive Orbital Altitude Selection Process

No party that filed comments in this proceeding appears to support the Commission's proposal to inject itself into the highly sensitive decision process regarding the most appropriate orbit for a given NGSO satellite system. Therefore, the Commission should not require NGSO system applicants that seek to deploy their constellations in the LEO region above 650 km to specify why they have chosen a particular orbit.[60]

Even NASA observed that such an information disclosure requirement would be of minimal efficacy, explaining that a satellite operator's decision regarding its choice of orbit should be informed by space traffic management "best practices" and, consequently, should be evaluated and chosen *much earlier* than during the typical licensing effort.[61] Moreover, as Boeing and others explained, satellite operators already have sufficient incentive to choose the most appropriate orbits for their missions and the Commission should not regulate in this area.[62] Further, operators of small satellites often will not know the exact orbit their satellites will be launched into so such information disclosure requirements will be unnecessarily burdensome.[63]

The Commission should recognize that the primary purpose of such an information disclosure requirement would not be to assess whether a satellite operator has chosen the most appropriate orbit, but rather to determine the period of time that may be necessary for the satellites

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[60] *See NPRM*, ¶ 31.

[61] *NASA Comments* at 1.

[62] *GNO Comments* at 8.

[63] *USSR Comments* at 18.

to reenter the Earth's atmosphere following the end of their mission lives.[64] Disclosure of the target orbital altitude alone, however, will not be adequate to make this determination.[65] Instead, as SpaceX explained, the Commission would also need to require the disclosure of information regarding the design of the spacecraft, including its ratios of mass to area, which "can vary greatly" across different spacecraft and spacecraft orientations and can affect the rate in which its orbit will passively decay.[66]

Rather than have the Commission collect and try to analyze such detailed information to evaluate when a satellite would reenter the Earth's atmosphere at the end of its mission life, the Commission's administrative resources would be better served through a requirement that satellite operators complete their own analysis and report to the Commission the results of this assessment in terms of the predicted reentry period for satellites that will be retired through atmospheric reentry. Such an approach would be far more efficient and equitable to all parties involved, but, as discussed below, it should be coupled with an objective and transparent metric for compliance.

I. The Commission Should Refrain From Adopting an Information Disclosure Requirement Regarding the Length of the Deorbit Process Unless it Adopts an Objective Criteria as Guidance

A number of parties filed comments in this proceeding supporting new restrictions on the deorbit period for NGSO satellite systems following the end of their operating missions. NASA, however, explained that its analysis shows that as long as short duration spacecraft adhere to the pre-existing 25-year reentry rule, the negative contribution to the orbital environment resulting

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[64] *Aerospace Comments* at 10; *CSSMA Comments* at 10.

[65] *SpaceX Comments* at 19.

[66] *Id.* at 19-20.

from such satellites is not significant.[67] Other parties also urged the Commission to retain NASA's 25-year disposal benchmark,[68] with many of them explaining that a shorter requirement would be very harmful to small satellite operators such as researchers and amateurs.[69]

In stark contrast to those supporting retaining the 25-year re-entry rule, a number of existing satellite operators argued that NASA's recommendation should be disregarded and a much shorter reentry period should be required,[70] advocating for a reentry period of no more than twice the mission life,[71] possibly with a post-mission cap of five years.[72] The push for a much shorter reentry period, however, was in no instance accompanied by any technical analysis or assessment of the actual impact that a shorter reentry requirement may have on the presence of debris. Such proposals also lacked the support of NASA. Therefore, the Commission should refrain from adopting a specific metric regarding the permissible deorbit period for retired satellites until further analysis and assessment is carried out by other federal agencies with expertise in this area. Concurrently, the adoption of an information disclosure requirement addressing the reentry

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[67] *NASA Comments* at 4 and 7.

[68] *Iridium Comments* at 8-9; *Aerospace Comments* at 17; *CSSMA Comments* at 16; *ARRL Comments* at 6.

[69] *CSSMA Comments* at 16-17; *USSR Comments* at 12-13; *Tyvak Comments* at 1; *GNO Comments* at 16; Comments of Radio Amateur Satellite Corporation, IB Docket No. 18-313, at 4 (Apr. 5, 2019) ("*RASC Comments*"); Comments of ARRL, The National Association for Amateur Radio, IB Docket No. 18-313, at 6 (Apr. 5, 2019) ("*ARRL Comments*").

[70] *OneWeb Comments* at 22; *Intelsat Comments* at 5-6; *Iridium Comments* at 8-9; *Integrity Applications Comments* at 1; *D-Orbit Comments* at 4; *Satdfr.org Comments* at 3; *SWF Comments* at 5; *GNO Comments* at 16; Comments of the United Church of Christ, IB Docket No. 18-313, at 3 (Apr. 3, 2019) ("*UCC Comments*").

[71] *OneWeb Comments* at 22; *Intelsat Comments* at 5-6; *Integrity Applications Comments* at 1.

[72] *OneWeb Comments* at 22; *SpaceX Comments* at 6; *Iridium Comments* at 8-9; *Maxar Comments* at 13; *Integrity Applications Comments* at 1.

period of retired satellites should also be deferred until an objective and transparent metric can be adopted that is supported adequately by a cost/benefit analysis of its impacts both to debris mitigation and to the U.S. commercial space industry.

J. The Commission Should Not Adopt Rules Addressing the Potential Use of Highly Congested Orbits

Boeing agrees with the Commission's observation that it may be advisable for new NGSO satellite constellations to avoid deployment in altitudes that have very high amounts of debris in order to minimize risk.[73] Nevertheless, as Boeing and others have explained in their comments, satellite operators already have sufficient incentive to select orbital altitudes that permit the safe operation of their constellations while concurrently serving the specific needs of their intended end users.[74] Further, as NASA explained, the selection of an operator's orbital altitude must be done very early in the constellation design process[75] and it is unreasonable to attempt to second guess these decisions during the license application process. Therefore, the Commission should refrain from adopting restrictions on the use of highly congested satellite orbits by U.S. licensed satellite operators and instead continue to permit satellite operators to reach their own conclusions regarding the altitudes that would best serve their economic needs subject to the constraints of the international coordination process.

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[73] *See NPRM*, ¶ 33.

[74] *Boeing Comments* at 18; *GNO Comments* at 8.

[75] *NASA Comments* at 4.

K. The Commission Should Not Require that All NGSO Satellites Operated Above a Certain Altitude Must Have Propulsion Capabilities

Boeing continues to oppose the adoption of a blanket rule that all NGSO satellites that would operate above a certain altitude must have propulsion capabilities.[76] It is worth noting that NASA also does not support the adopt of a propulsion requirement, indicating only that the possible need for propulsion be driven by the spacecraft's ability to meet the 0.001 lifetime collision risk rule and the 25-year rule.[77] Other parties concurred that propulsion capabilities should not be required,[78] suggesting that, rather than mandate that all satellites operating above the ISS have propulsion capabilities, the FCC should require that all operators demonstrate an ability to control the trajectories of their spacecraft and the capability to execute timely and effective collision avoidance maneuvers.[79] Further, as discussed below in Section III.P., although maneuverability using drag or electronic propulsion obviously does not produce the same range of motion as compared to liquid propulsion,[80] these alternative techniques are adequate to create sufficient maneuverability to execute collision avoidance measures.[81]

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[76] *See NPRM*, ¶ 34.

[77] *NASA Comments* at 4.

[78] *Orbcomm Comments* at 11; *CSSMA Comments* at 12-13.

[79] *OneWeb Comments* at 13-14; *GNO Comments* at 7-8.

[80] *NASA Comments* at 6; *GNO Comments* at 10; *CSSMA Comments* at 13-14.

[81] *GNO Comments* at 10; *CSSMA Comments* at 13-14.

L. The Commission Should Explore the Adoption of Limits on Variations in NGSO Orbits for Large Satellite Systems

As Boeing has advocated in other proceedings, the Commission should consider the adoption of limits in the maximum variations that are permissible in the orbits of NGSO satellite systems. NASA endorsed the establishment of orbit variance limits as a method to determine a spacecraft's acceptable proximity to other active spacecraft.[82] Although NASA and others observed that further work is necessary to establish a durable value for this variance based on relevant factors,[83] NASA acknowledged that, at the very least, requiring satellite operators to disclose this information may be beneficial to adjacent operators.[84] Further, the disclosure of such information would assist domestic and international organizations in studying the various factors that would be relevant to any future requirements in this area.

M. The Commission Should Adopt Reasonable Measures to Ensure the Successful Tracking of NGSO Satellites

All parties that addressed the issue supported a requirement that every satellite should be capable of being tracked. Many parties also supported allowing satellite operators to continue to decide whether to employ active or passive tracking measures.[85] Further, satellites should not be required to have active tracking measures if the satellite can be tracked through other means, such as if they are larger than 10 cm.[86] Although a few parties argued that it is not always possible to

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[82] *NASA Comments* at 4.

[83] *Id.*; *see also Lockheed Comments* at 9-10; *Orbcomm Comments* at 17; *LeoSat Comments* at 4; *CSSMA Comments* at 10.

[84] *NASA Comments* at 4.

[85] *OneWeb Comments* at 24; *Iridium Comments* at 7; *CSSMA Comments* at 11.

[86] *USSR Comments* at 6 and 11.

track objects larger than 10 cm,[87] these references appeared to address the tracking of smaller objects in higher orbits (such as GSO), which is much higher than where small satellites such as Cubesats are routinely deployed.

A number of parties advocated in favor of requiring active tracking technologies,[88] but none of these parties explained why passive tracking techniques are insufficient. Instead, the current difficulty faced by tracking entities does not appear to be the identification of the location of small satellites, but determining which small satellite is under the operation and control of which licensed entity. This could be resolved simply by requiring all satellite licensees to disclose following launch which of the satellites that are being tracked are under their control. Further, as NASA explained, caution should be exercised in relying on active tracking methods because they usually cease to function once the spacecraft power is shut down and also because active tracking methods are not sufficiently supported by the organizations conducting tracking.[89]

Therefore, the Commission should continue to give satellite operators flexibility in choosing whether to employ active or passive tracking methods, as long as the method chosen will be effective. Further, the Commission should encourage, but not require, satellite operators that employ passive measures to take steps to facilitate tracking, such as including corner reflectors on the spacecraft.[90]

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[87] *Aerospace Comments* at 11.

[88] *Lockheed Comments* at 10-11; *Intelsat Comments* at 5; Comments of Keplerian Technologies, Inc., IB Docket No. 18-313, at 1-12 (Apr. 5, 2019) ("*KTi Comments*"); *Integrity Applications Comments* at 6.

[89] *NASA Comments* at 5; *see also SWF Comments* at 4 (arguing that additional research is needed on the development of reliable active tracking techniques).

[90] *Intelsat Comments* at 5; *Aerospace Comments* at 11-12.

N. The Commission Should Require Disclosure of Launch Information with Federal Tracking Entities

All parties appear to agree that satellite operators should share basic ephemeris data with the Air Force's 18th Space Control Squadron ("JSpOC").[91] Some of those parties, however, observe that such information sharing is already standard industry practice and therefore it does not need to be regulated.[92]

If such information disclosure is required by the Commission, it should be limited to information that is actually relevant to the day-to-day tracking of satellites, including the initial deployment orbit and trajectory, and any subsequently planned maneuvers. A few operators produced a longer list of disclosure requirements,[93] much of which may not be relevant to JSpOC's core tracking mission. Therefore, such additional information should not be required unless it is specifically required by the Air Force.

O. The Commission Does Not Need to Require Operators to Certify That They Will Take Measures to Avoid Collisions

A number of satellite operators supported the Commission's proposal to require all satellite licensees to certify that, upon receipt of a conjunction warning, the operator of the satellite will take steps to assess and to mitigate the risk of an on-orbit collision.[94] None of these parties, however, made any attempt to explain why such a certification requirement is

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[91] *See, e.g., LeoSat Comments* at 4; *Intelsat Comments* at 5-6; *Orbcomm Comments* at 8.

[92] *CSSMA Comments* at 11.

[93] *See, e.g., SpaceX Comments* at 13-14 (supporting mandatory ongoing disclosure of updates on satellite orbital parameters, satellite health, ability to perform collision avoidance maneuvers, any planned maneuvers, as well as any non-functional satellites or anomalies).

[94] *Id.* at 14; *LeoSat Comments* at 4; *Intelsat Comments* at 6; *Orbcomm Comments* at 8.

needed. Satellite operators have substantial incentives to avoid on-orbit collisions involving their satellites.[95] Further, as SIA explained, the text of the Commission's proposed rule may inhibit the flexibility of satellite operators by preventing them from employing reasonable and adequate steps to avoid a collision if those measures fall short of the Commission's proposed requirement that "all possible steps" must be taken.[96] Although SIA supports revisions to the proposed rule to provide additional flexibility, a more efficient approach would be to conclude that such a certification requirement is unnecessary and should not be adopted.

P. The Commission Should Not Adopt Information Disclosure Requirements Regarding Maneuverability and the Anticipated Avoidance Maneuvers for Satellites Absent Objective Guidance Regarding the Methods and Frequency that are Presumptively Acceptable

Several parties supported a requirement that satellite operators must disclose the extent of the maneuvering capabilities of their satellites in order to avoid collisions with other satellites.[97] Although Boeing recognizes the potential value of such a disclosure requirement, it opposes its imposition absent the adoption of objective and transparent criteria by the Commission regarding what level of maneuverability is adequate to justify the grant of a license. Further, the actual techniques employed to complete satellite maneuvers is often highly proprietary[98] and therefore, if disclosure is required, it should be permitted to be made on a confidential basis.

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[95] *GNO Comments* at 10; *ASE Comments* at 4.

[96] *SIA Comments* at 7-8.

[97] *SES/O3b Comments* at 3; *Orbcomm Comments* at 11; *CSSMA Comments* at 12-13.

[98] *LeoSat Comments* at 5 (arguing that, due to the proprietary nature of maneuvering technologies, disclosure of this information should not be required); *GNO Comments* at 10 (same).

With respect to the adequacy of different maneuvering techniques, as Boeing and others have acknowledged, the use of drag or electronic propulsion for satellite maneuvers may not be as responsive as liquid propulsion systems,[99] but that does not mean they are inadequate. Instead, the overall sufficiency of a maneuvering strategy depends on the amount of time prior to a potential collision event that a corrective maneuver must be initiated.[100] Electric propulsion has the ability to adjust the orbit trajectory of an NGSO satellite by several kilometers in less than a day. When coupled with onboard GNSS-based orbit determination systems that significantly reduce the prediction errors of the orbit trajectory, the spacecraft is capable of responding effectively and adequately one day before the predicted conjunction—well within the three-day warning period currently provided by tracking bodies.[101]

The Commission should also refrain from requiring satellite operators to disclosure the number of collision avoidance maneuvers each satellite is expected to make or is capable of making.[102] The number of such maneuvers for large NGSO systems may be very high, but should not raise a regulatory concern because NGSO system operators have sufficient incentive to minimize the number of such maneuvers to only what is required to operate their systems on a cost effective basis. Further, the number of maneuvers that a satellite is capable of making is usually a function of the type and extent of the maneuver involved. In any event, the Commission should

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[99] *See NASA Comments* at 5-6; *GNO Comments* at 10; *CSSMA Comments* at 13-14.

[100] *OneWeb Comments* at 13.

[101] During ascent operations, the most fuel-efficient approach to produce a change in the predicted orbit state is to temporarily turn off the propulsion system. During the operational mission, however, the propulsion system can be effective by turning it on to apply thrust in a desirable direction.

[102] *SpaceX Comments* at 13.

refrain from requiring the disclosure of such information absent the adoption of transparent and objective criteria regarding the amount of maneuvering that would be deemed acceptable to justify the grant of a license.

Q. The Commission Should Not Adopt Information Disclosure Requirements Addressing the Launch of Multiple Satellites on a Single Launch Vehicle

A number of parties opposed requiring satellite operators to disclose information about their potential use of launch providers that may deploy multiple satellites using the same vehicle. As some parties explained, a satellite license applicant is unlikely to have first-hand information about such procedures, particularly at the licensing phase of a mission.[103] Because of this, such a requirement would be extremely burdensome on the operators of small satellites.[104] Such disclosure requirements are also unnecessary because satellite operators and launch providers already have adequate incentive to ensure the reliability of these missions.[105] This is demonstrated in part by the fact that multi-satellite launches have become the norm within the industry due to their proven track record of successful deployments on a cost effective basis.

The only party that appeared to support such a disclosure requirement was Orbcomm and it is unclear whether the concern it expressed would be resolved through the imposition of a disclosure requirement on U.S. licensees. Specifically, Orbcomm had difficulty identifying the operators of a number of small satellites that were launched simultaneously into an orbit near its satellites.[106] Orbcomm expressed the need for the adoption of regulations to ensure that the

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[103] *Spaceflight Comments* at 5-6.

[104] *USSR Comments* at 18.

[105] *CSSMA Comments* at 5.

[106] *Orbcomm Comments* at 14-16.

mission operator (as compared to the satellite operators) assumes responsibility for the correct deployment of multiple satellites from a launch vehicle.[107] Such regulation, however, would arguably be outside the jurisdiction of the Commission, raising the possibility, as suggested by a number of smaller operators, that the FAA may be the appropriate party to impose any such obligation on launch providers.[108] Of course, prior to the adoption of such rules, it would be necessary to determine the extent of the capability of the manager of a multi-satellite launch to precisely control the altitude into which each small satellite is launched.

R. The Commission Should Not Adopt Design and Fabrication Reliability Requirements for Large NGSO Satellite Constellations

Most parties agree that the Commission should not adopt design or fabrication reliability requirements for large NGSO systems[109] and, if a requirement is adopted, a reliability metric of 0.999 is not achievable.[110] Any design or reliability requirements would have to be developed by satellite industry engineers and would be extremely difficult to validate or enforce.[111] Further, the potential benefits of such requirements are unclear absent objective and reliable standards for testing compliance as well as safe harbors for demonstrating compliance.[112]

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[107] *See id.* at 15.

[108] *USSR Comments* at 18; *GNO Comments* at 10-11.

[109] Comments of Sirius XM Radio Inc., IB Docket No. 18-313, at 5-6 (Apr. 5, 2019) ("*SiriusXM Comments*"); *LeoSat Comments* at 5; *Orbcomm Comments* at 17; *GNO Comments* at 11; *CSSMA Comments* at 15.

[110] *OneWeb Comments* at 8-9; *Iridium Comments* at 4; *SiriusXM Comments* at 5-6; *LeoSat Comments* at 5 (arguing it would require triple redundancy); *Orbcomm Comments* at 17; *GNO Comments* at 11; *CSSMA Comments* at 15.

[111] *LeoSat Comments* at 5-6.

[112] *USSR Comments* at 15-16.

Instead of adopting design or reliability requirements, various parties have suggested alternative approaches. For example, a group of small satellite operators noted that the critical issue in orbital debris management is not design reliability, but disposal reliability, and that issue is already addressed in the *NPRM* through the proposed adoption of a disposal reliability metric.[113]

As an alternative, OneWeb suggested that the Commission require rigorous pre-launch testing for any satellite intended for operation above the ISS,[114] Boeing, however, does not support this proposal because satellite operators already possess ample incentive to thoroughly test satellites prior to launch.

OneWeb also suggested that satellites of a new design should be launched initially in small numbers until their on orbit performance can be verified, and in the event that satellite failures are evident in early deployments, the problem should be understood and corrected before more are launched.[115] Similarly, Iridium suggests that most satellite operators be required to notify the Commission of any on-orbit satellite failures and identify and correct the root causes of the failure on the ground prior to being permitted to launch any additional satellites.[116]

Although each of these measures is clearly prudent, none of them warrant federal regulation. Instead, satellite operators clearly have sufficient economic incentives to take these steps, as evidenced by the fact that each of the proposals are already the norm within the satellite industry. Therefore, the Commission should refrain from adopting design or reliability

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[113] *CSSMA Comments* at 15.

[114] *OneWeb Comments* at 9.

[115] *OneWeb Comments* at 10-11.

[116] *Iridium Comments* at 5.

requirements for NGSO satellites and also refrain from mandating any particular level of ground or in-orbit testing of satellites of a new design or following a spacecraft failure.

S. The Commission Should Adopt Reasonable Requirements for Reentry Disposal Reliability

Boeing supports NASA's proposal for the adoption of a three-tiered metric for the disposal reliability of satellites:

- 0.90 disposal reliability for individual spacecraft,
- A higher level of reliability for individual satellites operating in constellations of more than 100 satellites, and
- A reliability level of 0.99 for individual satellites operating in very large constellations (1000 satellites or more).[117]

Boeing also concurs with NASA's conclusion that a reliability level of 0.999 should never be required because it will not provide much additional benefit and may not be achievable, at least not in an affordable manner.[118]

Numerous other parties expressed support for metrics that are comparable to NASA's recommendation. For example, OneWeb supported a probability level of 0.90 for small NGSO constellations and 0.95 for large constellations.[119] LeoSat also argued that a probability level of 0.90 should be sufficient on a per satellite basis for constellations of less than 150 satellites.[120] The Aerospace Corporation further argued that a metric of 0.90 is adequate for small

[117] *NASA Comments* at 6.

[118] *See id.*

[119] *OneWeb Comments* at 28.

[120] *LeoSat Comments* at 6.

constellations, with a higher metric needed for larger constellations.[121] In addition, a group of small satellite operators explained that a probability level of 90-95 percent should be sufficient for individual satellites, with a higher level (95-99 percent) imposed on large constellations of more than 100 satellites.[122] Given the general consensus on this issue, the Commission should adopt NASA's recommendation for disposal reliability metrics.[123]

T. The Commission Should Not Require the Launch of NGSO Satellites to an Initial Altitude of Below 650 Kilometers

No satellite operator expressed support for the Commission's proposal to require that all satellites that will operate at an altitude of 650 km or higher be initially deployed into orbit below 650 km and then raised to a higher orbit following testing.[124] Even NASA counselled against this proposal, recommending instead that the above-discussed disposal reliability metric be used rather than requiring an initial deployment altitude below 650 km followed by satellite maneuvers to a higher operational altitude.[125] NASA explained that the Commission's proposed practice would add complexity to the deployment of the spacecraft and would be unlikely to significantly reduce the risk of satellite failures.[126]

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[121] *Aerospace Comments* at 14.

[122] *GNO Comments* at 12.

[123] Although Boeing agrees that the Commission should avoid adopting regulations in this proceeding that impose duplicative requirements, Boeing disagrees with Lockheed's contention that a disposal reliability metric would be duplicative with the Commission's existing casualty risk assessment. *See Lockheed Comments at 13*. Instead, a reentry disposal method could be extremely reliable, but still impose a casualty risk.

[124] The only party that expressed support for this proposal was a pastor in the United Church of Christ. *See UCC Comments* at 3.

[125] *NASA Comments* at 7.

[126] *See id.*

Other parties also questioned the efficacy of this proposal and raised concerns that it would jeopardize the underlying economics of satellite systems,[127] while also placing some operators in violation of their FCC build out milestones[128] and proposed ITU due diligence requirements.[129] As SiriusXM explained, some satellite components, such as the solar panels, are not deployed until the spacecraft is at altitude and therefore they cannot be tested at lower orbits.[130] Instead, several operators suggested that the Commission should continue to encourage the industry norm of launching a few NGSO satellites to their full intended orbit for testing before the remaining constellation is launched.[131] Satellite operators should also be permitted to determine the appropriate lengths of such tests,[132] including completing them in weeks or months rather than the Commission's proposal of "a certain number of years."[133]

U. The Commission Should Not Require Satellites to Automatically Initiate Disposal Measures Upon a Loss of Power or Contact With the Ground

Satellite operators were uniformly opposed to the mandatory use of satellite disposal mechanisms that initiate automatically upon a loss of power to the satellite or contact with the

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[127] *OneWeb Comments* at 24-25; *Lockheed Comments* at 13-14; *Aerospace Comments* at 14; *LeoSat Comments* at 6-7; *Orbcomm Comments* at 11-12; *GNO Comments* at 13.

[128] *OneWeb Comments* at 24-25.

[129] *See, e.g., CPM Report on technical, operational and regulatory/procedural matters to be considered by the World Radiocommunication Conference 2019*, International Telecommunication Union, § 3/7/1.3.2 (March 22, 2019) (discussing milestone based proposals requiring a certain number of satellites to be operated in the notified orbital plane for the NGSO system within a certain deadline).

[130] *SiriusXM Comments* at 6.

[131] *OneWeb Comments* at 25-26; *GNO Comments* at 12.

[132] *GNO Comments* at 12.

[133] *See NPRM*, ¶ 48.

ground.[134] As many of them explained, such technologies are not sufficiently mature for actual use and, if used prematurely, could increase the risk of a collision.[135] This is because many disposal procedures are much too complex to be completed on an automated basis, often taking months of active monitoring and control to ensure the spacecraft reenters the Earth's atmosphere safely without creating collision risks with other objects.[136]

The Commission should also reject the argument of one company that, rather than require the automatic initiation of deorbit procedures, the Commission should require the use of a fully autonomous decommissioning device on the satellite that would duplicate, with degraded performance, most of the critical functions of a spacecraft.[137] Such a proposal would greatly increase the cost of satellites and would actually reduce their reliability. Satellite manufacturers such as Boeing already ensure the high reliability of their satellites by incorporating redundancy in critical communication and control systems. Autonomous systems, in contrast, may not provide true redundancy with the primary systems on the satellite and may not be available as a backup for other critical communication and control functions.

The more prudent approach is to continue to employ redundancy in critical systems. Further, regulation in this area is unnecessary because satellite manufacturers and operators already have adequate incentive to employ these precautions. Instead, the Commission should solely impose its above-discussed requirement that the satellite be designed with a reliability

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[134] *OneWeb Comments* at 26; *Lockheed Comments* at 14; *Aerospace Comments* at 14-15; *LeoSat Comments* at 7-8; *Orbcomm Comments* at 17-18.

[135] *OneWeb Comments* at 26; *Lockheed Comments* at 14; *Aerospace Comments* at 14-15; *LeoSat Comments* at 7-8; *Orbcomm Comments* at 17-18.

[136] *GNO Comments* at 12.

[137] *D-Orbit Comments* at 3.

ranging from 0.9 to 0.99 (depending on the constellation size) that the satellite disposal will be effective. Such an approach would be technically neutral and would permit satellite manufacturers to continue to determine the more cost effective and reliable means to achieve this requirement.

V. The Commission Should Continue to Encourage the Development of Direct Retrieval, But the Technology is Not Ready for Commercial Use

Satellite operators agreed that technologies under development for the direct retrieval and servicing of satellites are not yet ready for commercial use and, if used prematurely, could create more orbital debris than they were designed to remove.[138] NASA concurred with this position, explaining that it envisions satellite direct retrieval as a long term goal which should not be permitted to detract from near-term efforts to address orbital debris.[139] Satellite operators also asserted that the FCC should not dictate the type of re-entry method used for NGSO satellites.[140] Instead, as Boeing explained in the previous section of these comments, the Commission should rely solely on its regulatory requirement that all satellite be designed with a reliability ranging from 0.9 to 0.99 percent that the satellite disposal will be effective.

Although the Commission should not dictate the use of specific satellite reentry technologies, Boeing has no objection to the suggestion of some parties that satellite manufacturers be encouraged (but not required) to install devices on spacecraft that may facilitate direct retrieval and servicing in the future such as the inclusion of grappling fixtures, radar corner reflectors, and

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[138] *Aerospace Comments* at 15-16; *LeoSat Comments* at 6; *D-Orbit Comments* at 5; *GNO Comments* at 14.

[139] *NASA Comments* at 7.

[140] *OneWeb Comments* at 27; *Lockheed Comments* at 14-15.

optical reflectors on satellites.[141] Although the inclusion of such devices would be affordable and not add excessively to a satellite's weight, other proposals, such as requiring that retraction of deployed appendages to reduce its collision cross section, would be exceedingly burdensome and unreliable.[142] In any event, federal regulation in this area is premature.

W. The Commission Should Adopt New Information Disclosure Requirements on Reentry Casualty Risk, But Only if It Concurrently Quantifies the Presumptively Acceptable Risk

Boeing continues to support the codification of NASA's recommendation that the probability of human casualty for an uncontrolled satellite reentry should be set at 1 in 10,000 for any debris in excess of 15 joules.[143] Further, the metric should be applied on a per-spacecraft basis.[144]

Other satellite operators also supported this position.[145] In contrast, OneWeb argued that the NASA metric should be applied on an aggregate basis to an entire constellation, but provided no technical analysis or justification explaining its support for this significant change to the NASA standard.[146] Some satellite operators also supported substantially more aggressive regulatory measures, such as requiring all NGSO satellites to fully demise,[147] or requiring targeted re-entry

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[141] *Aerospace Comments* at 16; *GNO Comments* at 16.

[142] *Satdfr.org Comments* at 3.

[143] *NASA Comments* at 7.

[144] *See id.*

[145] *Iridium Comments* at 10; *CSSMA Comments* at 17.

[146] *OneWeb Comments* at 18-19.

[147] *Iridium Comments* at 10; *SpaceX Comments* at 17; *Satdfr.org Comments* at 3.

that ensures that satellites land in uninhabited areas.[148] Although such measures can be encouraged, they are not technically neutral and could greatly inhibit growth and development in the U.S. satellite industry by prohibiting the use of materials that are not fully demisable. Instead, the Commission should incorporate the NASA recommendation into its rules and continue to permit satellite operators to decide on their own how they will comply with this standard.

X. The Commission Should Codify its Policies for GSO License Term Extensions

Nearly all operators of GSO satellites urged the Commission to codify its rules for GSO license extensions, but to refrain from adopting a five-year limit on such restrictions, explaining that a longer extension period should be granted if the circumstances so warrant.[149] As Intelsat explained, many non-U.S. administrations grant satellite landing rights based on the period of the underlying operation license and, therefore, the issuance of a limited license extension period would also limit the GSO landing rights in some countries thereby creating additional burdens for the operator and its end users.[150] Therefore, Boeing agrees that the Commission should refrain from adopting a five-year limit on GSO license extensions.

A number of GSO satellite operators also asserted that applicants for license extensions should not be required to certify that no single point failure exists in the spacecraft.[151] As they

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[148] *SpaceX Comments* at 17.

[149] *Lockheed Comments* at 15-16; *Echostar Comments* at 7; Comments of AT&T Services, Inc., IB Docket No. 18-313, at 2 (Apr. 5, 2019) ("*AT&T/Directv Comments*"); *Intelsat Comments* at 10; *Eutelsat Comments* at 4-5; *SIA Comments* at 6-7; *contra* Comments of ViaSat, Inc., IB Docket No. 18-313, at 8 (Apr. 5, 2019) ("*ViaSat Comments*").

[150] *Intelsat Comments* at 10-11.

[151] *AT&T/Directv Comments* at 2; *Intelsat Comments* at 9; *Eutelsat Comments* at 4.

explained, given the use of redundant components by satellite manufacturers such as Boeing, the existence of a single point failure does not necessarily prevent a GSO satellite from operating in a productive and reliable manner for many years into the future.[152] Further, if a satellite operator is required to retire a GSO satellite prematurely, it will likely result in an increase in unnecessary orbital debris though the premature launch of a replacement GSO satellite.

Y. The Commission Should Refrain From Adopting Special Disclosure Requirements for Satellites Engaged in Proximity Operations

Boeing continues to believe that it is unnecessary for the Commission to adopt disclosure requirements for proximity operations because the Commission already receives adequate information from satellite applicants regarding any risks for collisions between space vehicles through its other existing and proposed orbital debris mitigation reporting requirements. The Aerospace Corporation and others echoed this position, explaining that this issue is already adequately addressed in the Commission's existing collision avoidance analysis with respect to large objects.[153] Further, even those operators that expressed support for such an information disclosure requirement expressed concern regarding the lack of clarity in the *NPRM* regarding how this information will be used by Commission staff in its license application review process.[154] Therefore, the Commission should refrain from adopting this proposed information disclosure requirement.

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[152] *AT&T/Directv Comments* at 2; *Intelsat Comments* at 9; *Eutelsat Comments* at 4.

[153] *Aerospace Comments* at 18; *Space Logistics Comments* at 7-8.

[154] *GNO Comments* at 17.

Z. The Commission Should Update its Rule for Orbit Raising to Cover Both GSO and NGSO Satellites on a Fully Coordinated Basis

Boeing continues to concur with the *NPRM* proposal to expand the reach of the Commission's rules for orbit raising so that they apply to both GSO and NGSO satellites.[155] Boeing also continues to support the *NPRM* proposal to change the Commission's rules regarding the regulatory status of satellites undergoing the orbit raising process. Specifically, Boeing and others expressed support for the elimination of regulatory language indicating that communications with transiting satellites must "accept interference" from all other satellites and communications with a transiting satellite must "cease operations" if unacceptable interference to other satellites occurs.[156]

In contrast, SiriusXM opposed a change in the rules, raising a legitimate concern that in-service satellites should never be subject to interference from satellites engaged in orbit raising except on an emergency basis.[157] Boeing fully agrees with this position. To address this concern, however, the operator of a satellite being raised must coordinate that operation sufficiently so that the risk of causing interference to operational satellites is mitigated sufficiently.[158] At the same time, it is impractical to suggest that communications with a satellite being raised may have to be interrupted if interference does occur. Therefore, to adequately address both of these necessities, the Commission's rules should be revised to indicate that both in-service satellites and those being raised must be operated on a co-equal basis following the

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[155] *See NPRM*, ¶¶ 70-71.

[156] *Intelsat Comments* at 4-5; *Orbcomm Comments* at 9; *contra Viasat Comments* at 7-8 (arguing that the existing rule is sufficient and should not be changed); *Eutelsat Comments* at 6 (same).

[157] *SiriusXM Comments* at 7.

[158] *See id.*

completion of a sufficient coordination process to ensure that unacceptable interference does not result to either party.

AA. The Commission Should Not Adopt a Requirement that Satellite Telemetry, Tracking and Command Communications Must be Encrypted

The Commission should refrain from adopting a requirement that telemetry, tracking and command communications for satellite operations be encrypted. As numerous parties explained, it is often unnecessary for satellite operators to encrypt their control signals in order to keep them secure.[159] Other security measures can be used by satellite operators and, in those cases in which encryption is appropriate, satellite operators already have adequate incentive to employ it.[160] Requiring encryption of command signals would also be unnecessary because, as several operators explained, it would be extremely difficult for an unauthorized party to commandeer a satellite and cause it to harm any other space objects.[161] Further, as Intelsat explained, encrypted command links may actually make it more difficult to recover control of a failed satellite and therefore should not be required.[162] Instead, the decision regarding whether to encrypt command signals should be left to the discretion of the satellite operator which is the party with the greatest incentives and the greatest insight to make an appropriate determination on this issue.[163] The Commission should also consider Eutelsat's proposal that, to enhance the security of satellite control systems,

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[159] *See id.* at 8-9; *Orbcomm Comments* at 13; *RASC Comments* at 7; *CSSMA Comments* at 19.

[160] *AT&T/Directv Comments* at 6-8.

[161] *Aerospace Comments* at 18; *SWF Comments* at 7; *CSSMA Comments* at 19; *GNO Comments* at 19 (arguing that the text of the *NPRM* seems unclear in articulating the type of risk that would sought to be addressed by requiring encryption of control links).

[162] *Intelsat Comments* at 11-12.

[163] *Eutelsat Comments* at 6-7.

satellite operators should be permitted to submit their choice of command frequencies to the Commission on a confidential basis.[164]

IV. THE COMMISSION SHOULD NOT IMPOSE INDEMNIFICATION OR INSURANCE REQUIREMENTS ON SATELLITE OPERATORS

The Commission should not adopt indemnification or insurance requirements on satellite operators. The U.S. government has never incurred civil liability for damages resulting from an accident involving an FCC-licensed satellite and such a claim is highly unlikely given the fact that the relevant international agreements limit claims to those filed by one sovereign administration against another.[165] Further, as Boeing detailed in its comments, in the highly unlikely event that the U.S. government did incur liability resulting from an accident involving a FCC licensed spacecraft, the U.S. government could easily initiate a civil action to secure recovery from the relevant operator.[166] Thus, a complex indemnification agreement is be unnecessary. In addition, as a number of parties explained, the imposition of indemnification and/or insurance requirements would add another layer of burden and expense on U.S. satellite operators, further encouraging them to secure licenses from other countries.[167]

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[164] *See id.* at 8-10.

[165] *CSSMA Comments* at 20.

[166] *Boeing Comments* at 37-39.

[167] *Lockheed Comments* at 18-19; *Echostar Comments* at 7; *AT&T/Directv Comments* at 5-6; *CSSMA Comments* at 20-21; *SIA Comments* at 8-10; *Spaceflight Comments* at 6.

The imposition of an indemnification requirement would also force most satellite operators, to secure insurance for the entire life of the satellite, including its disposal process. Given the fact that few operators currently secure insurance covering the entire lifetime of their satellites,[168] it is unclear whether such insurance could be obtained on reasonable terms.[169] As one party explained, currently, only five percent of LEO satellites are subject to on-orbit insurance, so the insurance industry would need to mature significantly in order to expand into this area.[170]

It is also unclear whether the imposition of a requirement to secure insurance for the operational life and disposal of a satellite would actually incentivize operators to take greater efforts to avoid the creation of orbital debris. In order for insurance providers to adjust premiums based on the level of risk involved, the insurance industry must be able to sufficiently eliminate variables in the risk assessment process in order to calculate the likelihood of recovery by the insured. Given the length of the orbital life of a satellite and the various external conditions that can result in a failure, it may not be possible for insurance providers to make granular adjustments to premiums in order to encourage operators to employ certain measures over others.[171] Therefore, the Commission's underlying goal in adopting an insurance requirement —incentivizing the use of safe practices— would not be achieved.

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[168] *SiriusXM Comments* at 9 (explaining that many operators decide as a business matter to retain insurance only for initial stages of a satellites operations); *Lockheed Comments* at 18 (same).

[169] *Orbcomm Comments* at 19; *CSSMA Comments* at 20.

[170] *GNO Comments* at 19.

[171] *SWF Comments* at 8; *GNO Comments* at 19; *CSSMA Comments* at 21-22; *Tyvak Comments* at 1.

It is also unclear whether the Commission is the appropriate party to impose indemnification or insurance requirements on U.S. satellite operators. As Intelsat explained, the Commission may not have statutory authority to adopt indemnification requirements.[172] Instead, Congress should ultimately consider whether indemnification or insurance requirements should be imposed on U.S. satellite operators.[173] To this end, it should be noted that, rather than impose indemnification requirements on U.S. launch providers, Congress sought to encourage the growth of this industry by providing U.S. launch providers with catastrophic indemnification *coverage* in the event of an accident.[174] In this way, Congress sought to promote the growth of this critically important industry in the United States, rather than impose additional burdens on it.

V. CONCLUSION

The Commission should work closely with other federal agencies that have expertise and an executive mandate to develop comprehensive standards and regulations to governing the mitigation of orbital debris. The Commission should also harmonize its proposed rules with international bodies and regulators from other space faring nations to ensure that orbital debris management is addressed on a harmonized basis worldwide. Finally, the Commission should ensure that its rules are objective and transparent and do not require the disclosure of information without concurrently identifying the metrics and thresholds that are presumptively adequate to warrant Commission approval. Only in this way can the Commission effectively address orbital

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[172] *Intelsat Comments* at 12-15; *Space Logistics Comments* at 11-13.

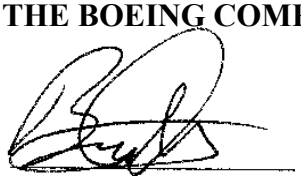
[173] *Space Logistics Comments* at 11-13.

[174] *CSSMA Comments* at 21.

debris management while avoiding significant competitive harm to the rapidly growing commercial space industry in the United States.

Respectfully submitted,

THE BOEING COMPANY

By: 

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